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FISH CULTURE IN CANADA

BY

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By Professor E. E. Prince, Dominion Commissioner of Fisheries, Ottawa, President of the Society.

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Fish-culture is, at once, one of the most ancient and one of the most modern of human pursuits. It is one of the most ancient, for the Chinese at a time so remote that it cannot be determined. are known to have reared fish, not only as quaint ornamental pets, but for use at table; and we know that the Greeks and Romans fully appreciated the utility of the artifical culture of fish. Lucullian feasts would have been impossible, but for the fish-pond's ample supplies. The ancients, says one authority, "were not satisfied with stocking fish-ponds which they had constructed for the purpose, but carried their foresight to the point of filling lakes, formed by nature, with the spawn of fish which they threw into them." (Columella, De Re Rustica Bk. viii., Sec. 16). In Christian times, fish-culture was not neglected and the mediæval monasteries were always provided with a fish-pond, ensuring suitable fare for Friday feasts. A fish-pond was regarded as necessary, no less than the buttery, the brewhouse,and the kitchen.

Protection of adult fish and systematic fattening were the main features of old-world fish-culture, but the Chinese as the French Jesuit, Jean Baptiste Duhalde, has recorded, procured the eggs of fishes, and cared for them in hatching tanks. The Romans, as we have seen, adopted the Chinaman's plan to some extent.

Modern fish-culture, to adopt a Hibernicism, has taken a great step in advance by taking the process a step further back, and by manipulation of the parent fish secures the ripe eggs, controls their fertilization, and incubation, and rears the fry, when hatched, to a more or less advanced stage of growth.

A French monk, Dom Pinchon, has been credited with first accomplishing, in the fifteenth century, the artificial fecundation of trout eggs; but competent authorities are of opinion that he simply collected naturally impregnated eggs. It was not until 1747 that a Westphalian officer, Lieut. Ludwig Jacobi experimented with the eggs of fishes, by actually mingling the milt and eggs, and carrying out fish-culture from the fecundation of the ova to somewhat advanced stages of the liberated fry or young brood. He reared trout until they were six months old, and founded modern fish-culture in the true sense of that term. The importance of his work was fully recognized, for his memoir was printed in Paris in 1770, and King George the Third, granted him a life pension in the following year. Karl Lund, in Sweden, followed close in the wake of Jacobi. In Italy, Rusconi (either in 1834 or 1835), and in Switzerland, Agassiz and Vogt, about 1836, minutely investigated the early stages of the eggs and young of fishes, while John Shaw, in the year of the Queen's Coronation, Knox, Young, Boccius, and others, from 1840 to 1850, added considerably to our knowledge of the larval development of the salmon and other species of fish. Rémy and Géhin, two French fishermen of La Bresse, appear to have practised fish culture in France in 1842, and the subject was brought to the attention of the public by the notable treatises of de Quatrefages and of Coste, the latter organizing in 1850, a large fish-breeding establishment with the authority of the Minister of Agriculture. France has ever since maintained a high place in the world of aquaculture.

It was not until 1853, so far as I can ascertain, that any attempt was made upon this continent to artificially breed fishes. Dr. Theodatus Garlick of Cleveland, Ohio, was the pioneer. He obtained parent brook-trout in Canada, taking them across from Port Stanley in Ontario, to his establishment in Ohio. He was an enthusiast, and his exhibits of young fish, hatched from Canadian trout-eggs, were a feature for many years at Agricultural Exhibitions in the various States bordering on the great lakes. Canada soon followed suit. The initial attempts were, of course, largely experimental. The late Mr. Samuel Wilmot claimed to have originated fish-culture in Canada; but I find the claim to be disputed, and with justification, by a venerable

and respected citizen of Ottawa, Mr. Richard Nettle. Stimulated no doubt by recollections of famous streams in his native Devonshire Mr. Nettle, as early as 1856 or 1857, began the incubation of salmon and trout eggs for purposes of artificial stocking, in hatching tanks in the City of Quebec. He disputed the accuracy of the claim frequently put forward on behalf of Mr. Wilmot. The Bishop of Ottawa, (Dr. Hamilton) incidentally confirmed the claim of Mr. Nettle in a recent conversation, his lordship informing me that he himself saw the young fish and the hatching arrangements about the time referred to. Mr. Nettle was then Superintendent of Fisheries for Lower Canada. From a report by the late Mr. Wilmot, dated Dec. 31st, 1878, it appears that he commenced experiments in fish-hatching in 1865, eight or nine years later than Mr. Nettle's experiments, and he carried it on as a private enterprise until the Dominion Government took the work over and gave M . Wilmot an appointment as a Government official. In 1866 Mr. Wilmot acted as a fishery officer, with authority from the Government of Upper Canada, and on May 30th, 1868, he became an officer under the Department of Marine and Fisheries; but it was not until eight years later (1876) that he became Superintendent of Fish Breeding. For his initial experiments he was paid, in 1869, the sum of $2,000 by Order in Council.

Thus fish-culture in Canada, at first a private enterprise on a small scale, received a kind of semi-official sanction, but in 1868 it became distinctively a branch of the Dominion Government service, the Newcastle Hatchery, possessed by Mr. Wilmot, being transferred to the Department of Marine and Fisheries. This hatchery, Mr. Wilmot affirmed, in his report dated Feb. 3rd, 1875, "has been the nucleus from which all of the National and State fish-breeding establishments in Canada and the United States of America have taken their rise." Additional hatcheries were soon built, the famous Restigouche Salmon institution in 1872, (twice rebuilt), and the Miramichi Hatchery in 1873. In 1874 the Gaspe Hatchery was commenced, and in 1875 a large mill was purchased at Tadoussac and converted into a fish-breeding establishment, supplanted by a new building later. The work expanded, so that Mr. Wilmot, in Feb. 1875, was able to speak of five hatcheries in Canada, four of them in full operation.

Much interest naturally centres in the Newcastle Hatchery on Lake Ontario, where thirty-five years ago the work commenced. The building, enlarged and improved, is situated on a small stream at the head of a small creek or marsh opening into the lake near Bowmanville, and about thirty-five miles east of Toronto. A sheltered and secluded valley of great sylvan beauty encloses the site, but the work has always been handicapped by its distance, both from good spawning grounds, and from suitable areas for planting the fry. Mr. Wilmot erected the hatchery, as was natural, near to his own residence, and at a time when salmon frequented Lake Ontario, and resorted to the creek in question for purposes of spawning. For many years salmon have been practically extinct in these waters, and the hatchery failed in its original purpose of keeping up the supply of Lake Ontario salmon, which Mr. Wilmot claimed to be indistinguishable from the sea-going Atlantic Salmon. From 1868 to 1873 over a million fry were sent out from this parent hatchery (an average of 200,000 per annum.) A small private hatchery was also carried on during these earlier years of Canadian fish-culture, by the well-known salmon fisherman and merchant, the late John Holliday. Mr. Holliday was born on the banks of the famous salmon river, the Scottish Tay, and was stimulated, no doubt, by the salmon-culture work at Stormonthfield, in Perthshire, commenced in 1853 by the proprietors of the salmon fisheries on the Tay. He built a hatching establishment on the Moisie River (north shore of the Gulf of St. Lawrence), which has continued its operations to the present time. Messrs. Brown and Co., also erected a trout hatchery at Galt, Ont., and, in 1868 had no less than 10,000 parent trout impounded in one of their ponds for the purpose of taking spawn for hatching purposes. Other hatcheries privately conducted with zeal and success might be named, such as the Credit Forks Hatchery carried on by Mr. Chas. Wilmot, the Silver Creek establishment near Toronto and others.

In the United States, it was not until 1871 that fish-culture became a recognised department of work under the auspices of the Federal government. Previous to that year individual States had made attempts in this direction, indeed, New Hampshire in 1865 had commenced fish-hatching operations, and agents were sent to

the rivers of Canada, where they were permitted (as Mr. Charles G. Atkins tells us) to take salmon from the spawning beds, and were thus enabled to secure some hundreds of thousands of eggs, which were "hatched with a measure of success." Pennsylvania and the State of Connecticut followed in 1866. In 1867, 1868, 1869 and 1870 the States of Maine, New York, California, New Jersey, and Rhode Island, severally began fish-culture in their respective territories.

In Canada the salmon and brook-trout naturally claimed first attention ; but in 1867 and again in 1868, whitefish were successfully impregnated and hatched by Mr. Wilmot as he tells us in one of his reports. A pioneer fish-culturist in the United States, Mr. N. W. Clark of the State of Michigan has been credited with first successfully handling the eggs of the whitefish (*Coregonus clupeiformis*) on this continent, but the statement published by Mr. Wilmot gives four or five years priority to the Canadian, if, as Mr. Clark said, the first whitefish eggs in the United States were artifically hatched in 1872 (see U. S. Fish Comm. Report, p xxvi, 1872-73). In 1875 a whitefish hatchery of large capacity was completed at Sandwich, Ontario, and has carried on, with marvellous success, the incubation of the eggs of that species on the Detroit River.

Under the zealous and indefatigable Samuel Wilmot, fish-culture in Canada made rapid strides, and the Dominion has generally been acknowledged to be in the front rank in this work. France and Germany were in advance, it is true, so far as exact scientific methods and knowledge were concerned, and the United States has taken the lead in making most munificent provision from the public funds for pisciculture, and Great Britain has set a worthy example in private enterprises and in costly experiments under skilled superintendence, witness the Stormouthfield*, Howietown, Cray's Foot, and Guildford establishments.

Canadian fish-culture was no doubt conducted in a rough and ready manner, the Superintendent and his staff being practically self-taught, so that many blunders were committed, and many erroneous methods for some years adopted. But the conditions were so favourable, the purity of the water and the abundance

*Now supplanted by Dupplin

and coldness of the supply, the robust and healthy nature of the parent fish, and similar circumstances compensated for much that was lacking in manipulation and technical knowledge, during the early years of Canadian fish-culture. "The most important requisite . . . . is pure water, it is indeed to a hatchery what coal is to a steam-engine" said the late Sir James Gibson Maitland (Int. Fisheries Exhib. London 1883) to whom Scottish fish-culture owed so much. It may be doubted whether any other country can offer conditions so favourable as Canada, and it is certainly remarkable that in the vast number of fry of various species, hatched year after year in the Dominion hatcheries, abnormal or deformed fishes hardly ever occur. Monsters as a rule are familiar enough in the tanks of European hatcheries, but nothing is so rare in Canadian establishments.

The following brief *resume* of the progress of fish-culture operations in Canada gives at a glance the stages of its advance. The Newcastle (Ont.) hatchery, as already stated, came under government control in 1868, or rather 1867, and there have been hatched, since that date, Lake Ontario salmon, Pacific spring salmon,* brook trout, black bass, German carp, Great Lake trout, dorè or pike perch and lake whitefish. Ontario salmon became practically extinct within a few years after the hatchery was started, and Pacific salmon do not appear to have thriven, one or two questionable records only of their capture having been announced, while black bass proved only partially successful and carp were a total failure. Brook trout, being mainly a game fish and of inferior commercial importance, was eliminated in 1892, though its culture was a marked success. Thus the hatchery has confined its work to the incubation of Great Lake trout, the eggs being secured by government officers at Wiarton, Georgian Bay, and the Lake whitefish, transferred from the Sandwich hatchery, early in the year, generally February, in the eyed stage.

The following table embraces details respecting the remaining 14 hatcheries arranged for conciseness and convenience of reference.

*Professor Spence F. Baird generously sent from the United States at various times eggs of the Quinnat or Spring salmon.

FOUNDED	LOCATION.	KIND OF FISH HATCHED.	ANN'L OUTP'T
1874	Deeside, Restigouche R.	Salmon	1 to 3 millions
	South Esk, Miramichi R.	Salmon and Sea Trout	1 to 1½ "
1875	Tadoussac, Saguenay R.	Salmon and Hybrid Ouananiche	1 to 3 "
	Gaspé, P. Q.	Salmon	1 to 1½ "
1876	Sandwich, Ont.	Whitefish, Pike Perch or Dore	10 to ov'r 70 mil
	Bedford near Halifax, N. S.	Salmon, Whitefish and Great Lake, and Rainbow Trout	1 to 5½ mill'ns
1880	Grand Falls, St. John R. N. B.	Salmon Whitefish and Great Lake Trout	2 to 4 "
	*Dunk R, P. E. Island	Salmon	1 "
1881	Magog near Sherbrooke, P. Q.	Whitefish and Great Lake Trout	1 to 4½ "
1882	*Sydney, Cape Breton.	Salmon	1 to 2 "
1884	New Westminister, Fraser R., B. C.	Pacific Salmon (Quinnat and Sockeye)	2 to 10 "
1890	Ottawa Hatchery.	Whitefish and Great Lake Trout	3 to 7 "
	Bay View near Pictou, N. S.	Lobsters	60 to 100 "
1894	Selkirk, Red River, Manitoba.	Whitefish	4½ to 19 "

The total quantity of fry of all kinds distributed from the foregoing institutions since fish-culture has been carried on by the Dominion government, that is from 1868 to 1899, both years inclusive, is no less than 2,650,468,200. The average annual quantity during the last 20 years has been 128,000,000. In 1895 the output was extraordinarily large, amounting indeed to nearly 300 millions. For the last nine years vast quantities of lobsters have been hatched, the annual average being no less than 100,000,000. Deducting these from the total output, we find that the average output each year, during the last twenty years has been 85 millions, mainly of the three kinds, salmon, Great Lake trout and lake whitefish (*Coregonus*), which are all fishes of great economic value.

Whatever may be said for or against the artificial hatching of fish, no fair-minded critic can doubt, that the distribution year after year, of this enormous quantity of young fish must have benefitted our waters to an incalculable extent. Artificially hatched fry, unlike those hatched naturally on the spawning beds, must in the eyes of some critics, be more at the mercy of enemies when newly planted. Nothing, however, could be more helpless and unprotected than naturally hatched fry, and those turned out from hatcheries are really less at the mercy of enemies, inasmuch as they are always some days old, frequently several

*Dunk River hatchery was destroyed by fire and Sydney hatchery has not been operated for three seasons pending the completion of a new Cape Breton hatchery.

weeks old, before being planted, and should be more sturdy and robust than the fry exposed immediately after hatching, on the natural spawning beds. Nor is the objection better founded that the fry are suddenly transferred from the warmer water of the hatchery to the colder water of the lake or river outside. Records, which have been kept, show that the water flowing rapidly and plentifully through the tanks is more equable and cold than the shallow waters outside. The fry, it is further contended, are untaught to seek shelter, and must be gobbled up by watchful enemies. This cannot be so. The eggs are all taken from wild fish, and the young inherit the instincts of their parents. Hence when the fry have been carefully watched at the time of planting, they have been noticed to act with alertness and intelligence, and at once dart off to shelter. All the stock objections are made in ignorance of the real facts, for the facts all prove the very opposite of the theories set forth by critics, usually arm-chair critics.

Fish-culture, at this late date, needs no advocacy or defence, yet recent unsolicited testimony may be adduced, sent to me as affording evidence of the success of the government hatcheries. A lake near Three Rivers, P. Q., was planted several years ago. It abounds at the present time with fine lake trout, says the member of parliament, who is my informant, although these fish did not formerly occur in it at all. A lake in Victoria county, Ontario, I have recently been informed by residents, is alive with trout consequent on being stocked by means of fry. Most visitors to the river Saguenay know the Tadoussac Hatchery, and the small lake adjacent to the building abounds in small salmon a few pounds in weight, the result of the surplus quantities of fry placed there by the hatchery officer. "On one occasion," says the officer in an official report "I permitted the Bishop of Chicoutimi, to fish in the hatchery lake. He was accompanied by the Rev. Mr. Mathieu, Superior of the Quebec Seminary, and the Rev. Mr. Lemieux, of Tadoussac, they were astonished at the number of young salmon that could be caught" A most convincing case came to my notice, however, on the testimony of a gallant and facetious member of the House of Commons, who bitterly complained that a New Brunswick lake, stocked with brook trout at much cost, had received also some Great Lake trout from a

Government Hatchery. The latter have so prospered and grown in size and numbers, that they are cleaning out the brook trout, formerly so abundant in it. The Club who lease the lake are anxious to exterminate the hordes of huge lake trout which are the direct result of fry planted there from Grand Falls Hatchery, and the use of nets has been resorted to, enabling some fine specimens of these "fresh-water sharks" to be captured. Deplorable as are the results from the Club's point of view, no better testimony to the success of the government's hatchery work could be adduced.

To most people fish-culture is thought to consist in taking some ripe mature fish, just before spawning, squeezing eggs from them, fertilising them, and placing them in jars or on trays, in a current of water until the young fish hatch out. Fish-culture is, however, much more than that, it includes at least half-a-dozen different methods. Of course, one method, and that most familiar, consists in obtaining ripe living fish of both sexes, and after subjecting them to the same process of careful and gentle pressure, mingling the two products in a spawning vessel or dish, where the eggs are rapidly fecundated, and then transferring the vivified eggs to the trays or hatching jars. The parent fish, being handled with care are returned to the water, with rare exceptions, alive and unharmed, and in the case of salmon usually continue the ascent up-stream, which had been interrupted by the hatchery officials. In B. C., it is said, the spawned fish frequently descend, but this may depend upon the sex, for Frank Buckland noticed that male salmon invariably bolt up-stream if disturbed, whereas the "hens" or female salmon bolt down stream. The fish do not die, as the signs of ripeness are readily visible to the expert officer's eye, and ripe fish are spawned painlessly and with the utmost readiness and ease. It is a curious fact that eggs from dead fish may be successfully used if death is recent. Thus the distinguished Russian naturalist, Owsiannikoff, in a paper read in 1869, before the Imperial Academy of St. Petersburg, stated that he had fertilised the eggs taken from dead fishes, and in most cases with success. Different species also may be crossed and hybrids readily produced but there are limits to the process due, no doubt, to certain microscopic peculiarities in the structure of the egg capsule.

Two methods of fertilisation have been adopted, the wet and the dry, and the latter has almost universally superseded the former. In the dry method no water is added until some moments after the ova and milt have been mingled and gently stirred with a feather or the fingers. In the early days of Canadian fish-culture the wet method was followed, and the eggs were placed in water before the milt was added, and a proportion of eggs always failed to be fecundated, hence the universal adoption of the so-called dry method.

Some of the different methods followed in obtaining eggs or fry may be here instanced.

(1) The parent fish are secured some time (days or even months) before spawning, and impounded until they become ripe and swollen. Whitefish are often kept in this way, and the plan has been adopted in Canada of confining salmon in tidal ponds for many months, and apparently without harm. Indeed the salt water prevents fungus, and as salmon take no food after leaving the sea, there is no difficulty in retaining them until the spawning season, and then taking the eggs and milt. After being kept from June or July until October or November the parent fish are liberated on being artificially spawned.

(2) The parent fish are netted at the spawning time near the breeding beds. Salmon, in British Columbia, are treated in this way, also Great Lake trout and whitefish. The parent fish are rarely injured, and are thus liberated in their native waters.

(3) Parent fish are captured and the eggs taken and fertilised, but the fish are killed and sent to market. This is the plan adopted in some cases by U. S. fish-culturists, especially with the Great Lake trout. It is unavoidable as a rule, with black bass and sturgeon, even when very ripe, as they refuse to yield their spawn. It is not adopted in Canada.

(4) Parent fish are impounded in ponds or enclosures, where they deposit and fertilise their spawn naturally. The spawn is then transferred to the hatchery and incubated artifically. Bass, maskinonge, perch, carp, sturgeon, etc., have been treated in this way.

(5) A similar plan to the last is followed excepting that the eggs are allowed to hatch out in the ponds where deposited.

(6) Instead of securing the parent fish, or obtaining the eggs after being deposited, the small fry, incubated and hatched naturally, are netted and used for purposes of stocking waters. Trout and black bass have been mainly introduced into new waters by this method. Black bass, when very young, devour each other, even when only a little over an inch in length, and the Caledonia (N. Y.) Hatchery officers have reported that their young black bass grow so rapidly that they must be shipped immediately after being collected in the adjacent marsh ponds. Nearly 400,000 of these fry are annually distributed from the American hatchery named.

It is plain that if we can secure the eggs from the ripe parent fish, fertilize them by the dry method, and hatch them under the care of experts, the results must infinitely surpass those possible under natural conditions, where a small proportion only can be expected to surmount all the dangers and difficulties of their environment. Let me give an illustration of this waste of eggs on the natural spawning beds—a waste not contrary to natural law, but obedient to the principle of compensation and adjustment, universal in the world of nature. In 1895 I spent some time closely observing certain spawning beds of the Fraser River salmon, commonly called sockeye or blueback. I noticed, not once, but scores of times, pairs of fish busy nesting, the male fish lingering near his partner until she shed a shower of eggs. Just as the eggs were cast into the rapid stream, the male fish had his attention attracted by a rival, and darted with lightening speed to drive him off, both male fish tearing at each other with gaping jaws, armed with formidable teeth, the teeth at this time being of abnormal size. Time after time I saw female fish wasting their eggs in this way, for the eggs deposited in the gravel by the female, while her partner was engaged in a fight twenty or thirty yards away, were unfertilized and would, of course, perish or be eaten by hungry enemies, suckers, trout, etc., which hovered near in hordes.

The curious fact repeately noticed by observers, that male salmon outnumber the female; and the fierce fights and numberless resulting deaths, may be a device for reducing the surplus number of one sex. "To me it is the strangest puzzle," said Frank Buckland, "why the male fish always predominate over

the female," and he asserted that frequently there occurred seven males where there might be not more than one female salmon. During the second year of the Restigouche Hatchery's work, the late John Mowat reported that the male fish were in excess of the female as two to one, and the late Alexander Russell, in his famous book "The Salmon," gave prominence to Shaw's not less interesting discovery, that in the young striped "parr" stage, male salmon are mature, "the male parr (alone) arrives at sexual maturity, and does and can impregnate the ova of the adult female salmon."

If, to the natural loss of enormous quantities of eggs by non-fertilization, be added the depredations of ducks, loons, herons and aquatic birds, not to speak of otters and four-footed enemies, as well as destruction by floods, by mud, gravel and ice, it is easy to see how great are the advantages offered by artificial incubation, and by caring for the eggs in properly equipped hatcheries.

Anglers, as a rule, favour fish culture, but there are exceptions, and the sportsman needs to be reminded that, whereas, the fish are liberated strong and uninjured after being artifically spawned, those taken by the angler's line shortly before the breeding season, are killed and prevented from fulfilling their task of peopling the waters with young brood. It is easy to hatch 90% of salmon eggs in a hatchery, whereas, Sir Humphrey Davy estimated that not six per cent. of the eggs deposited on the breeding grounds, come to perfection, and Stoddard held that only four or five fish fit for the table were the result of 30,000 ova on the spawning beds. The take of salmon in a single net may suffice to furnish enough eggs to keep up the supply of young fish, and it is the rule at the Government nets to liberate all fish not required, and these are allowed to ascend to the upper waters. Thus at the Tadoussac nets in 1889, 559 salmon were taken for the hatchery, but 310 of the largest were sufficient, and the remaining 249 were turned into the river again. This is frequently done. In most of the hatcheries reliance is placed upon the Departmental nets, managed by the hatchery officers. In these nets fish are trapped, and after being spawned are set free. In some cases parent fish are bought from local fishermen by special arrangement, but the plan has, on the whole, proved uncertain, as the fishermen asked exorbitant

prices, or ignored their agreement and shipped the fish straight from their nets to the markets, leaving the hatchery officers in the lurch. Many parties have entertained an ignorant prejudice against artificial hatching of salmon, not fishermen only, but men of education and social standing. Thus the lessees of certain rivers in Gaspe, refused to allow any salmon to be taken for hatchery purposes, and anglers who have been known year after year, to kill hundreds of salmon in famous pools, really spawning grounds, have declaimed against the inhumanity of taking the spawn from the small number of parent fish, which are ample for supplying a salmon hatchery.

Frank Buckland has truly observed that "the success of salmon egg-collecting depends upon very small circumstances, and he specifies seven necessary provisions to be made by the "spawner," viz, : a water-proof suit, spawning pans of large capacity, a long, shallow basket to hold the fish under water until wanted, hose flannel in yard lengths for wrapping the struggling fish when spawning, dry towel to wipe slime off the hands, moss and trays, and lastly, nets.

In a report published in the Marine and Fisheries Blue Book, 1896, I described all the types of fishes' eggs known to scientific experts. I grouped them under seven heads, according to their special features, and I pointed out that they varied in shape, size, external structure, etc. The smooth, spherical, pea-like eggs of the salmon, trout, whitefish, and the like, are far more favorable for artificial incubation than slimy eggs, eggs clinging in bunches, eggs in gelatinous strings, eggs covered with spines, oval eggs. and other varieties.

The eggs resembling peas vary in size in different species. A quart measure is frequently used in counting eggs on account of its convenience. The measure holds 57.75 cubic inches, and has been found to be capable of containing 3,300 land-locked salmon eggs ; 4,272 Atlantic salmon ; 3,696 Pacific salmon ; 5,525 Great Lake Trout ; 8,311 to 9,935 English Brown trout ; 12,063 to 13,998 American brook trout ; 24,363 striped bass ; 28,239 shad ; 36,800 lake whitefish ; 73,938 maskinonge ; 152,292 pike, perch or doré ; 233,280 tomcod ; 335,000 cod ; 496,000 smelt. In diameter the eggs vary from ¼ of an inch in the Atlantic salmon, and 3/16 of an inch in the brook trout, to 1/30

of an inch in the tomcod (*Gadus tomcod, Walb*) or 1/25 of an inch in the silver hake (*Merlucius*).

When the ripe female fish is being spawned by the hatchery operator, the eggs run freely in a stream into the pan or dish, previously rinsed in clean water, the operator gently pressing the abdomen with one hand, while with the other he holds the fish firmly in the region of the anal fin, the head of the fish being secured under the armpit, if a large fish like a salmon. A male fish is then treated in the same way, the milt flowing into the spawning pan amongst the eggs, and the eggs are stirred with a feather, thus securing fertilization. After being washed, the eggs are placed either upon black Japanned tin trays, 15 in. x 10 in. x 7/8in, perforated with small holes and holding about 2000 salmon eggs, or they are placed in glass vases 20 in. x 6 in. in diameter. The former are more suitable for salmon and trout, the jars being best for whitefish. Zinc trays are found hurtful to eggs, the officer at the Miramichi hatchery reporting in 1874 that a large number of salmon eggs were poisoned from this cause. The eggs, being alive, require abundant oxygen, hence a continuous stream of water must pass over them day and night until they hatch out. Under natural conditions river-water, of course, pours over the eggs, but fish culturists are agreed that spring-water is preferable for hatching purposes, not only because the temperature is more equable, but is purer and more free from debris and vegetable matter. In 90 to 120 or 150 days, the young fish burst from the eggs; shad, however, take only from two to five days, and cod hatch in ten to thirty days. Most of the valuable fresh-water species, like the trout and whitefish take many months. In special cases where the hatching of sturgeon and shad has been attempted as in Chautauqua Lake, N. Y., hatching boxes with double wire screen, top and bottom, have been placed in a running stream, or if containing maskinonge eggs, have been sunk at a depth of four or five feet in the lake. The fry are transferred to large tanks for periods of a few days or a few weeks, and are distributed in large cylindrical cans, nearly two feet high and twenty inches in diameter, the narrow neck of which is devised to hold ice in hot weather, in order to keep the water cool.*

*Fry are conveyed up some salmon rivers in floating crates or perforated boxes, and 25 miles of a river can be planted in a day.

The young fish carry beneath the body a small bag of food yolk, and require no other food until it is used up—a few days sufficing in some species, a few weeks in others. If possible, the fry should all be planted before the store of natural food is exhausted. In stocking lakes or rivers it is best to select inshore shallows not frequented by large fish, or rocky ridges and banks far from shore. The fish travel by rail or team for long distances without serious harm, if ice is used with care. Short distances are, however, best; indeed, Mr. Samuel Wilmot urged the establishment of small supplementary hatcheries, where the advanced eggs could be sent just before hatching, and the fry more safely distributed from them. "This system of carrying, or rather trying to carry, young fry to distant points (particularly where no speedy means of travel by railway is to be found) should be discontinued (said Mr. Wilmot in 1877), because the time almost invariably spent in fruitless journeys of this kind, could be so much better and more profitably applied at nearer points, where the safety of the young salmon in the transit could be relied upon." At times a few thousands of fry have been kept until they are four or five months old; but constant care is necessary, and a large proportion, as a rule, die when the fry are kept out of their natural habitat in lakes or rivers. The feeding of fry is not easy, as the quantity and kind of food require regulation, or the results may be fatal. In 1887 eight or ten thousand young salmon were retained in a pond at the Restigouche hatchery, and were fed during the summer, "yet they did not seem to thrive well, as but few were seen in October when the pond froze over (as Mr. Alex. Mowat reported)....I have very little faith in the attempt to grow salmon fry with artificial foods, with a view of realizing any benefit from the proceeding." Last year Mr. Mowat again kept some salmon fry (about 10,000) in outside tanks with an ample stream of water passing through. Mr. Mowat is one of the best practical fish-culturists living, and this experiment was a success owing to special attention, the fry growing satisfactorily until they were nearly six months old. The food consisted of finely ground raw fish and liver; but quite as important a matter was the intelligent manipulation and care of a zealous officer in charge. The fish were well fed, yet not overfed, and kept perfectly clean, by the removal of dead and decayed matter, especially waste food

particles. Many of this batch of fingerlings measured fully three inches in length. The growth of fishes, especially young fishes, varies extremely; thus brook trout are usually two inches long when four months old; three inches when eight or nine months old, and five inches when a year old. Lake trout are six inches long at the end of the first year, and black bass at the same age are four to six inches. Salmon, when confined in ponds, are often stunted in growth, thus 3,000 salmon fry were planted in a small lake near Louisburg, Cape Breton, in 1888. In 1889 they were three or four inches long, and in 1891 (in their third year) some were caught with the fly, but were not more than eight inches in length. A similar experiment at the Restigouche Hatchery, resulted in producing young salmon, seven inches long in the third year, and ready to descend to the sea.

Discretion is not always shown in the planting of fish suited to the waters selected. Carp have been a questionable benefit, black bass in some waters have been far from a blessing, and that splendid game fish, the maskinonge, proves to be a veritable fresh-water shark in some lakes. "If planted in many of the small inland lakes (says Mr. Annin, jr., Supterintendent of N.Y. State Hatcheries) the result will be that perch, pickerel and bass fishing would be greatly damaged." If predacious fish abound, it is useless to attempt stocking with a better class fish. The fry are inevitably exterminated. In Chautauqua Lake, N.Y., the U. S. authorities wisely decided to clean out that voracious ganoid, the bill fish (*Lepidosteus*), and in two seasons over 4,000 of these useless fish were captured in seines, pounds and traps, such extermination being often necessary before stocking begins. For some years the pike perch or doré (*Lucioperca* or *Stizostedion*) were hatched at Sandwich and at Ottawa. The first batch, about one million, were hatched in 1881, but partly on account of difficulties in securing ample supplies, this species was, after ten or eleven years, no longer embraced in the Government operations. Black bass too, for a time, were hatched at Newcastle, and German carp were also included, for one or two seasons, under the mistaken idea that it would introduce "into ponds and waters (to quote Mr. S. Wilmot's report) now depleted a highly esteemed description of food fish hitherto unknown in our country." A thousand young carp were, with the late Prof. Baird's

consent, brought from Washington to Newcastle in December, 1880. Some were planted in ponds in Manitoba, but apparently without result. Pacific salmon have also been introduced into the waters of the eastern provinces. In October, 1873, 20,000 Quinnat or spring salmon eggs were generously donated to the Newcastle Hatchery by Prof. Spencer Baird ; they hatched out in December, and were planted in April following. In 1874 a second lot was sent, and in Oct., 1875, a third consignment of 80,000, (of which half were sent to Tadoussac Hatchery), and in 1876 a further batch of 40,000, and in November a further shipment of 80,000. Other lots of many thousands were kindly given by the U.S. authorities, but the results appear to be decidedly inconclusive. A fish, 15 inches long, was described by Mr. Wilmot as being captured near the Newcastle Hatchery in 1876 in the creek there and regarded as a Quinnat. "It was totally unlike the ordinary grilse or smolt of the stream, and was a male with matured milt," said Mr. Wilmot. and he added, " The first lot of California eggs was received at this place in the fall of 1874 ; this salmon must, therefore, have been two years old from the egg." In July, 1877, several more, it said, were taken. The officer in charge of the St. John River Hatchery, N. B., reported in 1885 that there were grounds for regarding the planting of Pacific salmon (Quinnat) in 1881, as a success. He reported : " Just as soon as the fishermen set their nets in spring they began to capture a strange, and to them, peculiar species of salmon with which they were unacquainted. This gave rise to enquiries and investigation, which resulted in the fact that they were California salmon, averaging some seven or eight lbs in weight. Consequently they must have been some of the identical salmon that were hatched in the Rapide des Femmes Hatchery and put into the St. John River, four years ago last March." In March and April, 1881, 35,000 young California salmon had been sent to this hatchery.

Lobster hatching had been tried in Norway by Capt. Dannevig as early as 1885, and three years later Mr. Adolph Nielson commenced operations in Newfoundland. The United States also carried an artificial lobster hatchery. A fine building, 75 feet by thirty-five feet broad, was erected at Caribou Harbour, near Pictou, N. S., and began work in 1891. A

duplex pump and twenty horse-power steam engine, draw salt water from the bay, and a wharf running out to 20 ft. depth of water, enables tugs to come alongside with supplies of lobster eggs obtained by the hatchery officers at the canneries. The eggs, it may be mentioned, are carried attached to the swimmerets in bunches, under the body of the female lobster. Ripe and well-developed eggs are selected, and are known by their paler colour as compared with the deep green or black of the newly extruded eggs. With a spoon, the hatchery operator scrapes off most of the eggs, leaving some still adhering, including some that are unavoidably crushed or burst. Having visited several of the lobster canneries, and picked out egg-bearing lobsters sufficient to give him an adquate supply—the lobsters, of course, being alive and newly brought in from the trapping grounds—the operator at once conveys the eggs in buckets on board a tug to the hatchery, places them in upright jars or vases, slightly wider than whitefish jars, where they are kept rolling about by rapidly circulating sea water until they hatch. At a temperature of 56° or 58°F, they may hatch out in 24 hours; but they frequently take fourteen or fifteen days, if the temperature is lower and the eggs are not advanced in development. At a temperature of 40° or 50° F. lobster eggs take many months for the incubation process, but so favourable are the conditions at the Bay View Hatchery, Caribou Harbour; that the annual operations are frequently over in five or six weeks in May or June. The young fry are like little active shrimps, swimming head foremost in contrast to the adult lobster, and they are so cannibalistic that they must be planted at once. They are conveyed in barrels on board a tug, each barrel having a square lid cut out, at the side which is uppermost, for aeration, and the young lobsters are lifted by scoops or dippers, and scattered in the surface waters 3 to 10 miles from land. The method of scattering them by means of a hose pipe at the stern of the tug was not successful, the delicate fry being injured. Lobster fry are never found close inshore but are pelagic in habit, and frequent the surface of the sea many miles from land. The methods in vogue at the Canadian Lobster Hatchery appear admirable, and should ensure in due time, beneficial results for the lobster fisheries along the Atlantic coast. For the sake of clearness a brief summary of some of the features of Fish-culture in

Canada may be referred to in a concluding paragraph :—

(1.) Fish of supreme commercial importance only are hatched, hence species, which are chiefly valued for sport only, are excluded.

(2.) Eggs, the hatching of which is difficult or hazardous, e. g. black bass, maskinonge, sturgeon, etc., are not included. Results, commensurate with the expenditure of public money, are problematical in the case of such species.

(3.) As far as possible all parent fish are returned alive to the water after spawning.

(4.) Salmon are impounded in tidal ponds for many months prior to the breeding period in the fall. They cease to feed on entering the mouths of rivers, and the sea water keeps them free from fungus and disease. Lake trout and whitefish, also are kept in pens or pounds for a few days before being artifically spawned.

(5.) Fry are distributed gratis on the applications being officially approved, and the government bears the expense, wholly or partially, of shipment and planting.

(6.) Lastly the fry are all practically shipped in the recently hatched condition (three days to three weeks old). This is unavoidable when vast quantities, tens of millions, are handled. Retention of the fry would involve great expense and serious loss by death, and all the applications could not be filled.

It is hardly open to dispute that the planting, year after year for over 30 years, of countless numbers of young fry of valuable economic fishes must have vastly benefited the waters of the Dominion.

The hatching of cod, mackerel and other marine fishes has not so far been attempted in Canada. The eggs and fry of these fishes are not so favourable for the methods of artificial culture, and the vast numbers produced by each spawning female (a single cod shedding 9 to 10 millions of eggs each season), the extremely delicate pelagic character of the eggs, and the futility of handling successfully the fry, are the reasons which

have deterred the government from taking up this work. If Canadian fish-culture is doing anything to keep up the supplies of fish in our salmon rivers, our great lakes and inland streams, it is doing much. By introducing western species into eastern waters and *vice versa*, it may do more, and we may therefore be content to permit the illimitable ocean, open to all the fishing fleets of the world, to be recuperated by the unassisted methods of Nature herself.